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Career Goals and Educational Preparation of Aerospace Engineering and Science Students: An International Perspective

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Career Goals and Educational Preparation of Aerospace Engineering and Science Students: An International Perspective

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This article is based on the results of a survey of aerospace engineering and science students conducted in India, Japan, Russia, the United Kingdom, and the United States. The survey, conducted during 1994, is a Phase 4 activity of the NASA/DOD Aerospace Knowledge Diffusion Research Project, which attempts to understand the use and flow of information at the individual, organizational, national, and international levels in the aerospace industry. Phase 4 focuses on the international dimensions of aerospace.

In this article, we look at similarities and differences among aerospace engineering and science students from five countries in the context of two general aspects of educational experience. First, we consider the extent to which students differ regarding the factors that led to the choice of a career in aerospace, their current levels of satisfaction with that choice, and career-related goals and objectives. Second, we explore the importance of certain commu-

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nications/information-use skills for professional success, and the frequency of use and importance of specific information sources and products to meet students' educational needs.

Survey Demographics

Aerospace engineering and science students from several countries were included in the survey; the samples included both undergraduates and graduates, males and females. The students reflect the demographic composition of enrollees in the colleges and universities where the survey was conducted: the India Institute of Space, the India Institute of Technology, the University of Tokyo, the Moscow Aviation Institute, Cranfield and Southampton Universities in the United Kingdom, the University of Illinois at Urbana–Champaign, and Texas A&M University. Because the samples from each country are small, we do not assume that they represent the aerospace engineering and science student populations in India, Japan, Russia, the United Kingdom, and the United States. Given these limitations, the discussion of the data should be regarded as exploratory rather than conclusive, and the results should be interpreted cautiously.

Most students surveyed were male; the proportion of females ranged from 4% in Japan to 16% in the United States. All of the Russian and most of the U.S. and Japanese students were undergraduates. All of the Indian students and about 79% of the students in the United Kingdom were graduate students. All of the Indian students and just about all of the Japanese and Russian students were citizens of the country where they were attending school. About 45% of the students in the U.K. samples and about 13% of the students in the U.S. samples were not citizens of the country where they were attending school. Most of the students in the Indian, Japanese, and Russian surveys were bilingual; most were fluent in English. Few of the U.S. students were bilingual. About 70% of the U.S. students were members of a professional student (national) engineering, scientific, or technical society. About 29% of the Japanese students and about 16% of the Russian students were members of a professional student (national) engineering, scientific, or technical society.

Presentation of the Data

First, we present data about certain factors that led to the choice of a career in aerospace engineering, students' current levels of satisfaction with the choice, and students' career goals and professional objectives. Next, we provide data about the importance of communications and information-use skills for professional success and the receipt and helpfulness of instruction in these skills. Finally, we offer data on the use and importance of specific information sources and products for meeting students' educational needs.

Career Choice: Timing, Influence, and Satisfaction

Most of the students in the Japanese, U.K., and U.S. samples had made their career choices while in high school (or the equivalent). Most

Table 1 Influence (Importance) of Selected Factors on Career Choice of Aerospace Engineering Students

Factor	India (*N* = 59) Mean[a] (n)	Japan (*N* = 77) Mean[a] (n)	Russia (*N* = 117) Mean[a] (n)	United Kingdom (*N* = 127) Mean[a] (n)	United States (*N* = 142) Mean[a] (n)
Your parents encouraged your area of study/major	4.4 (54)	2.4 (65)	3.7 (102)	3.4 (118)	3.6 (136)
Other family members encouraged your area of study/major	3.4 (47)	1.9 (59)	2.3 (91)	2.8 (116)	2.9 (130)
Teachers encouraged your area of study/major	4.4 (50)	2.0 (57)	2.7 (99)	3.4 (115)	3.5 (135)
Career in your major/area of study will lead to financial security	4.3 (52)	3.4 (72)	3.1 (102)	4.2 (124)	4.4 (140)
Career in your major/area of study will provide many rewarding activities	5.7 (55)	6.0 (76)	3.1 (102)	6.0 (125)	6.1 (142)
Information on career opportunities available in your major/area of study	5.0 (58)	4.3 (72)	4.8 (100)	3.9 (120)	4.2 (139)

[a]Students used seven-point scale (where 7 was highest rating) to evaluate importance of each factor.

of the Indian and Russian students had made their career choices when they started or after they started college (or the equivalent). All students were asked what had influenced their decisions to pursue a career in aerospace engineering. The data in Table 1 indicate that the opportunity for a rewarding career was the most important factor in career choice among students from India ($X = 5.7$), Japan ($X = 6.0$), the United Kingdom ($X = 6.0$), and the United States ($X = 6.1$). Having access to information about aerospace engineering was the most important factor in career choice for students in Russia ($X = 4.8$). Other influential factors include 1) for the Indian students, access to career information about aerospace engineering and the encouragement of parents and teachers; 2) for the Japanese students, the availability of career information about aerospace engineering; 3) for the Russian stu-

Table 2 Importance of Career Goals (Aspirations) of Aerospace Engineering Students

Goal	India (N = 59) Mean[a] (n)	Japan (N = 77) Mean[a] (n)	Russia (N = 117) Mean[a] (n)	United Kingdom (N = 127) Mean[a] (n)	United States (N = 142) Mean[a] (n)
Engineering					
Opportunity to explore new ideas about technology or systems	6.5 (58)	6.3 (76)	5.9 (115)	5.8 (129)	6.2 (141)
Advance to high-level staff technical positions	5.2 (57)	5.3 (74)	4.3 (113)	5.2 (129)	5.1 (139)
Opportunity to work on complex technical problems	6.1 (56)	5.8 (76)	5.2 (108)	4.9 (129)	5.8 (141)
Work on projects that utilize latest theoretical results in your specialty	5.8 (59)	5.9 (76)	5.5 (111)	5.1 (128)	5.6 (140)
Work on projects that require learning new technical knowledge	6.1 (58)	6.0 (77)	5.3 (112)	5.5 (127)	5.8 (141)
Science					
Establish reputation outside your organization as authority in your field	5.6 (59)	4.5 (73)	5.4 (115)	5.2 (127)	5.4 (141)
Receive patents for your ideas	4.6 (56)	4.0 (74)	5.2 (109)	3.7 (126)	4.1 (137)
Publish articles in technical journals	5.7 (59)	4.5 (74)	4.3 (112)	4.3 (128)	4.5 (139)
Communicate your ideas to others in your profession through papers delivered at professional society meetings	5.4 (59)	5.2 (76)	4.9 (114)	4.7 (128)	4.6 (137)
Be evaluated on basis of your technical contributions	5.7 (58)	5.2 (77)	4.6 (110)	4.9 (126)	5.4 (139)
Management					
Become manager or director in your line of work	4.2 (58)	4.3 (67)	4.3 (109)	5.4 (128)	4.7 (142)
Plan and coordinate work of others	4.7 (59)	3.5 (73)	4.0 (112)	5.5 (128)	4.9 (157)
Advance to policy-making position in management	4.4 (57)	3.7 (74)	4.0 (109)	5.6 (125)	4.4 (140)
Plan projects and make decisions affecting organization	4.9 (57)	4.5 (72)	4.6 (111)	5.9 (129)	5.1 (141)
Be technical leader of group of less experienced professionals	4.1 (57)	3.9 (71)	4.0 (106)	5.2 (129)	5.2 (142)

[a]Students used seven-point scale (where 7 was highest rating) to evaluate importance of each goal.

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Table 3a Importance of Communications/Information Use-Skills for Professional Success

	IMPORTANCE				
	India (N = 59)	Japan (N = 77)	Russia (N = 117)	United Kingdom (N = 127)	United States (N = 142)
Skill	Mean[a] (n)	Mean[a] (n)	Mean[a] (n)	Mean[a] (n)	Mean[a] (n)
Communicating technical information in writing	6.4 (58)	6.0 (76)	5.2 (114)	5.9 (126)	6.2 (141)
Communicating technical information orally	6.1 (58)	5.9 (76)	5.3 (112)	5.9 (126)	6.3 (141)
Knowledge/understanding of engineering/science information resources	6.3 (58)	6.3 (77)	6.0 (110)	5.7 (125)	6.2 (141)
Searching electronic (bibliographic) databases	5.0 (50)	5.2 (72)	5.9 (109)	5.1 (126)	5.3 (139)
Using library	6.2 (56)	5.5 (75)	5.7 (111)	5.4 (124)	5.6 (142)
Using computer, communication, and information technology	6.5 (57)	5.9 (76)	6.4 (111)	6.3 (126)	6.6 (142)

[a]Students used seven-point scale (where 7 was highest rating) to evaluate importance of each skill.

dents, the encouragement of parents; 4) for the U.K. students, the likelihood of achieving financial security in the future; and 5) for the U.S. students, financial security in the future and access to career information about aerospace engineering.

Although most survey respondents had made well-informed decisions about choosing a career, many respondents are not as happy with their choices now as when they first made them. About 45% of the Indian students reported being happier now with their career choices than when they first decided on aerospace engineering. About 45% of the students in the United Kingdom and 62% of the Japanese students reported that they feel about the same now as when they first made their career choices. About 38% of the Russian students and 39% of the U.S. students indicate that they are not as happy now with the career choice as when they first made it. Taken collectively, the responses may indicate pessimism about employment prospects in the aerospace industry. This assumption could be tested by comparing the expectations of aerospace engineering students in the five countries with the expectations of their counterparts in other branches of engineering, for example, electrical and chemical engineering. After deciding to pursue aerospace engineering as a career, students formulate their career goals and professional aspirations. Survey respondents in the five countries were asked to indicate the importance to them of 15 career goals and aspirations, which were broadly grouped into engineering, science, and management career paths. Table 2 shows the students' responses. For students in India, Japan, Russia, and the United States, engineering-oriented career goals and aspirations—exploring new technology or systems, working on complex technical problems and learning new technical knowledge, and utilizing the latest theoretical results—were most important. For these students, developing a strong reputation as an authority in the field (a science-oriented career goal or aspiration) or becoming a technical leader of others (a management-oriented career goal or aspiration) did not appear to be as important. The Indian students indicated that science-oriented goals (presenting conference papers, publishing articles, and developing a reputation for technical contributions inside and outside the organization) were also important to their professional success. The U.K. students indicated that management-oriented goals (planning projects, making decisions affecting the organization, and planning and coordinating the work of others) were also important to their professional success.

Communications/Information-Use Skills—Importance, Instruction, and Helpfulness

The production, transfer, and use of information is a significant component of engineering work. Employers expect engineering graduates who enter the world of work to possess certain communications/information-use skills that enable entry-level engineers to be pro-

Table 3b Communications/Information Use-Skill Instruction Received and Helpfulness of Instruction

	RECEIVED				
	India (N = 59)	Japan (N = 77)	Russia (N = 117)	United Kingdom (N = 127)	United States (N = 142)
Skill Instruction	Percent (n)	Percent (n)	Percent (n)	Percent (n)	Percent (n)
Technical writing/communication	29.8 (17)	10.5 (8)	41.1 (46)	54.8 (69)	69.7 (99)
Speech/oral communication	17.2 (10)	13.2 (10)	43.8 (49)	61.1 (77)	62.7 (89)
Using library containing engineering/ science information resources	36.2 (21)	10.5 (8)	53.6 (60)	80.8 (101)	59.9 (85)
Using engineering/science information resources	43.1 (25)	9.3 (7)	59.5 (66)	61.1 (77)	63.4 (90)
Searching electronic (bibliographic) databases	24.1 (14)	11.7 (9)	17.1 (19)	75.4 (95)	57.0 (81)
Using computer, communication, and information technology	67.2 (39)	43.4 (33)	32.4 (36)	76.2 (96)	88.7 (126)

	HELPFULNESS				
	India (N = 59)	Japan (N = 77)	Russia (N = 117)	United Kingdom (N = 127)	United States (N = 142)
Skill Instruction	Mean[a] (n)	Mean[a] (n)	Mean[a] (n)	Mean[a] (n)	Mean[a] (n)
Technical writing/communication	5.9 (16)	5.9 (7)	5.2 (37)	5.2 (66)	5.1 (98)
Speech/oral communication	5.8 (9)	4.8 (10)	5.1 (39)	5.2 (75)	5.1 (87)
Using library containing engineering/ science information resources	6.0 (21)	5.1 (8)	5.9 (55)	5.0 (96)	4.8 (81)
Using engineering/science information resources	6.0 (22)	5.0 (7)	5.7 (57)	4.9 (75)	5.0 (86)
Searching electronic (bibliographic) databases	5.5 (13)	4.6 (9)	5.7 (16)	4.9 (92)	4.8 (82)
Using computer, communication, and information technology	5.9 (38)	5.1 (30)	6.2 (31)	5.5 (92)	5.8 (125)

[a]Students used seven-point scale (where 7 was highest rating) to evaluate helpfulness of skill instruction.

ductive immediately upon being hired. A survey of the literature and input from engineering professionals yielded a list of six fundamental communications/information-use skills that entry-level engineers should possess. The student survey respondents were asked to rate the importance of these same six skills for professional success, using a 7-point scale, where 7 was the highest rating. Their responses appear in Table 3a. Overall, the aerospace engineering and science students in this study consider communications/information-use skills important for professional success. Using computer, communication, and information technology; communicating technical information orally and in writing; and understanding how to use engineering/scientific information resources appear to be the most important communications/information-use skills needed for professional success. With the exception of the Russian students who indicated that communicating technical information in writing was the least important of the six skills for professional success, the survey respondents indicated that searching electronic (bibliographic) databases was the least important skill needed for professional success. Student survey respondents were asked if they had received in-

struction in the six communications/information-use skills and to rate the helpfulness of the instruction. Their responses appear in Table 3b. Higher percentages of U.K. students, U.S. students, and Russian students than Indian or Japanese students reported having received instruction in the six communication/information-use skills that they deemed important for professional success. Approximately 89% of the U.S. students, 76% of the U.K. students, 67% of the Indian students, 43% of the Japanese students, and 32% of the Russian students had received instruction in using computer, communication, and information technology. Approximately 70% of the U.S. students, 55% of the U.K. students, 41% of the Russian students, 30% of the Indian students, and 11% of the Japanese students had received instruction in technical writing/communication.

Approximately 63% of the U.S. students, 61% of the U.K. students, 44% of the Russian students, 17% of the Indian students, and 11% of the Japanese students had received instruction in speech/oral communication. Approximately 63% of the U.S. students, 61% of the U.K. students, 60% of the Russian students, 43% of the Indian students, and 9% of the Japanese students had received instruction in using engineering/scientific information resources.

Using a 7-point scale again, students were asked to evaluate the helpfulness of the instruction they had received. Overall, students rated the instruction they received helpful. Students gave the highest ratings to instruction in the use of computer, communication, and information technology, with a high of $X = 6.2$ and a low of $X = 5.1$.

The U.S., U.K., and Russian students gave high helpfulness ratings to instruction in technical writing and oral communication, followed by instruction in using a library containing engineering/science information resources and searching electronic (bibliographic) databases. The Japanese and Indian students gave high helpfulness ratings to instruction in using a library containing engineering/science information resources and technical writing.

Use and Importance of Information Sources and Products

Engineering has been described as knowledge-intensive work that requires the use of a variety of information sources and products. The information sources may be individu-

Table 4a Frequency of Use of Sources and Products Used to Meet Information Needs of Aerospace Engineering Students

	India ($N = 59$)	Japan ($N = 77$)	Russia ($N = 117$)	United Kingdom ($N = 127$)	United States ($N = 142$)
	Mean[a] (n)	Mean[a] (n)	Mean[a] (n)	Mean[a] (n)	Mean[a] (n)
Source					
Your personal collection of information	4.1 (59)	3.9 (76)	3.7 (103)	3.9 (125)	3.9 (140)
Other students	3.0 (59)	2.9 (77)	3.1 (106)	2.8 (122)	3.3 (140)
Faculty members	3.3 (58)	3.0 (76)	2.1 (104)	3.0 (124)	3.1 (140)
Library	4.3 (59)	3.4 (77)	3.0 (106)	3.9 (125)	2.7 (140)
Librarian	1.4 (54)	1.7 (77)	1.3 (103)	2.2 (123)	1.7 (140)
Product					
Textbooks	4.1 (59)	3.6 (77)	4.1 (106)	3.7 (125)	4.1 (140)
Handbooks	2.8 (58)	2.3 (77)	3.7 (106)	2.8 (124)	2.5 (138)
Journal articles	4.2 (59)	2.4 (76)	2.4 (104)	3.6 (125)	3.0 (140)
Technical reports	3.2 (58)	2.2 (76)	1.9 (90)	3.2 (126)	2.6 (139)
Conference/meeting papers	3.5 (59)	2.8 (77)	1.5 (93)	3.2 (127)	2.4 (140)

[a]Students used five-point scale (where 5 was always) to measure frequency of use.

als or specific resources within which knowledge resides or that point to the location of the desired/needed information. Given a list of specific information sources and products, the students who participated in this study were asked to evaluate their use and importance, using 5- and 7-point scales, respectively. Tables 4a and 4b show their responses.

Students in the five countries were given a list of five information sources: your personal collection of information, other students, faculty, library, and librarian (Table 4a). The U.S., U.K., Russian, and Japanese students made the greatest use of their personal collections of information; the Indian students made the greatest use of the library, followed by their personal collections of information. The U.S. and Russian students made the next greatest use of other students as sources of information; the U.K. and Japanese students made the next greatest use of the library. Using the services of a librarian received the lowest rating from students in all five countries. Students were also given a list of five information products: textbooks, handbooks, journal articles, technical reports, and conference/meeting papers. Overall, these students made the greatest use of textbooks and journal articles. They reported limited use of technical reports and conference/meeting papers, although for the Japanese students, conference/meeting papers were the second most frequently used information product.

The students were also asked to rate the importance of these same five information sources and products for meeting their information needs (Table 4b). Personal collections of information were rated most important by the U.S. and Russian students; the library by the U.K. and Indian students; and faculty members by the Japanese students. Personal collections of information were rated second most important by the U.K., Japanese, and Indian students; faculty members were the second most important source of information for U.S. students; and the library was the second most important source of information for the Russian students. Textbooks were rated the most important information product by the U.S., U.K., Russian, and Japanese students. Journal articles were rated the most important information product by the Indian students, and the U.K. students gave them an importance rating equal to the rating that they gave textbooks. In general, journal articles appear to be the second most important information product used by all the students who participated in this research.

Table 4b Importance of Sources and Products Used to Meet Information Needs of Aerospace Engineering Students

	India (*N* = 59)	Japan (*N* = 77)	Russia (*N* = 117)	United Kingdom (*N* = 127)	United States (*N* = 142)
	Mean[a] (*n*)	Mean[a] (*n*)	Mean[a] (*n*)	Mean[a] (*n*)	Mean[a] (*n*)
Source					
Your personal collection of information	6.2 (59)	5.3 (76)	4.9 (104)	5.6 (126)	5.7 (140)
Other students	4.2 (59)	4.2 (77)	4.4 (104)	3.7 (123)	4.7 (140)
Faculty members	5.2 (59)	5.4 (77)	3.9 (100)	4.7 (126)	4.9 (140)
Library	6.4 (59)	5.3 (77)	4.7 (104)	5.7 (125)	4.4 (140)
Librarian	2.2 (53)	2.4 (76)	1.9 (96)	3.5 (121)	2.4 (139)
Product					
Textbooks	5.9 (59)	5.0 (75)	5.7 (103)	5.5 (125)	6.1 (140)
Handbooks	4.5 (59)	3.4 (75)	5.6 (103)	4.2 (124)	3.7 (138)
Journal articles	6.4 (59)	4.0 (75)	4.5 (102)	5.5 (127)	4.7 (138)
Technical reports	5.1 (58)	3.4 (74)	3.8 (86)	4.7 (124)	4.0 (139)
Conference/meeting papers	5.4 (59)	4.5 (75)	2.7 (88)	5.0 (125)	3.7 (139)

[a]Students used seven-point scale (where 7 was highest rating) to evaluate importance.

They assigned relatively low importance to technical reports, conference/meeting papers, and handbooks.

Concluding Remarks

Current changes in the aerospace industry include increased collaboration and competition among aerospace producers in multiple countries. Multinational alliances are being established to produce and sell aircraft worldwide. An important consequence of increased collaboration and multinational alliances of producers is the rapid diffusion of aerospace knowledge among nations and the need to access and utilize knowledge that exists externally from the organization. The ability of aerospace engineers to produce, transfer, and use this knowledge is becoming crucially important in this kind of environment. U.S. aerospace engineering and science students are likely to find themselves working in companies involved in multinational alliances; consequently, they can expect to work with aerospace engineers and scientists whose educations and professional expectations may or may not be similar to theirs. The research report in this article has provided some insight into the educational preparation and professional expectations of aerospace engineering and science students in other countries.

Overall, the students who participated in this research remain relatively happy with the choice of a career in aerospace engineering, despite pessimism in some quarters about the future of the industry. Happiness with this career choice appears to be directly related to the timing of the decision, the availability of information about aerospace engineering careers, and perceived opportunities for professional growth and career satisfaction. Regardless of national identity, aerospace engineering and science students appear to share a similar vision of the profession in terms of their career goals and aspirations.

The data also indicate that aerospace engineering and science students are well aware of the importance of communications/information-use skills to professional success and that competency in these skills will help them to be productive members of their profession. Overall, the U.S. students have received more skills instruction than their international counterparts although all the students who had received communications/information-use skills instruction found it helpful. Collectively, all of the students who participated in the survey appear to use and value similar information sources and products, although some distinct differences appear by country. These differences may be attributable to variations in aerospace engineering curricula, sociocultural norms (for example, in Japan), or sociopolitical factors (for example, in Russia). Additional research would be needed to ascertain the sources of the differences, however, and to understand them more fully.

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